Description

The FE-366-TA is a dual channel bridge transducer amplifier and balance unit complete with filter, for data acquisition and processing applications. The unit is presented as a printed circuit card with amplifier fine gain and balance controls brought to the front edge of the card. Internal jumpers set gain, filter and bridge configuration.

Specification

Bridge section	Common bridge supply	
Power	Level	5V @40mA or 10V @30mA via internal jumper
	Stability	0.01%/°C.
	Regulation	<±0.1% change in Bridge Volts for ±10% input change.
Balance	Front edge control by screwdriver operated potentiometer develops shunt balance of bridge via selectable resistor.	
Completion	1/4 or 1/2 bridge completion is available for 120Ω and 350Ω bridge circuits and is configured via internal jumpers.	
Calibration	Remote shunt calibration via opto-couplers.	

Amplifier section	Two identical amplifiers and filters, each individually configurable	
Gain	Selection	Internal jumper links to give gains from 1 to 5000 in 1, 2, 5 steps.
	Vernier	Front card edge control x1 to x2.5.
	Accuracy	Step accuracy ±0.5%. T.C.<50ppm/°C.
	Linearity	Better than 0.01%.
Input	Impedance	>2MΩ excluding shunt balance resistor.
	Offset Voltage	<50µV (gain 1000).
	T.C.	<0.4 µV/°C.
	Bias Current	<600 pA.
	Offset Current	< ±450 pA ±0.4 pA/°C.
Common Mode	Rejection	90dB (gain 1000) dc-100Hz.
	Range	±10V.
	Protection	± 25V.
Noise	Input	<10µV pk-pk dc- 30kHz, <7µV pk-pk dc - 10kHz.
	Output	<1mV rms dc - 30kHz.
Frequency Range	Maximum	dc - 10kHz (x1 - x5000 gain). dc - 30kHz (x1 - x500 gain).
Slewing Rate	1V/µs	Typ.
Output	Voltage	Capability ±10V into 2kΩ, 5000pF max. Offset <±50 mV (at gain 5000)
Filter	Type	3 pole, preset by plug-in resistor network (5Hz - 10kHz) Gain Unity Roll Off 18dB/ Octave, 60dB/decade Offset ±5mV
	Characteristic	Butterworth standard, Bessel or Tchebychev to order.
Auto Zero	Using external auto zero module will correct an output offset of up to ±5V.	
Environment	Temp. Range	0°C to 50°C operating
Physical	Card size	7” x 2.65”. 2u high format (180mm x 67mm).

Specification

Table of Contents Page 1

1 FE-366-TA Amplifier Card Description

The FE-366-TA is a dual channel bridge transducer amplifier and balance unit, complete with filter, for data acquisition and processing applications. The card has been specially developed to provide high performance at low cost in multichannel applications. FE-366-TA is presented as a printed circuit card with amplifier fine gain and balance controls brought to the front edge. Internal jumpers set gain, filter and bridge configuration.
In the following text, the lower case letters a & b are used to differentiate between the two channels of the amplifier card.

Breakdown of amplifier:-

1. Bridge Power Supply
2. Bridge Balance and Completion system
3. Bridge Calibration system
4. Pre-Amplifiers
5. Low Pass Filters
6. Output Buffer Amplifiers

1.1 Bridge Power Supply

In the FE-MA32/40 mains powered system, the stabilised d.c. transducer supply voltage is generated by the modular power supply type FE-810-BPSA which delivers ±5 V (10V) with a 0 V centre tap.
The power supply is intended to power up to 40 - 350Ω bridges at 10 V and up to 32 - 120Ω bridges at 5 V.

For the FE-MM8, FE-MM16 and FE-MM40 DC powered systems, the stabilised d.c. supply is provided by the modular power supply type FE-810-BPSDC, which also gives 10V and 5V, but can also deliver +2.5 V relative to the 0 V centre tap.

For the FE-MM4, the stabilised d.c. supply is provided by the modular power supply type FE-813-BPSDC, which also gives 10V and 5V, and has a jumper to provide +2.5 V relative to the 0 V centre tap.

When required, the amplifier modules are able to carry fuses to prevent single card faults from limiting the power supply to the remaining cards. These fuses are replaced by links in standard modules and the system relies on the overload protection inherent in the power supply. In installations where inter-channel short circuit protection is required, the fuses may be fitted. (The PCB track must be cut for each fuse before fitting.)

Note that the front panel power indicator will flash if the bridge power supply is overloaded.

1.2 Bridge Balance and Completion system

For fractional bridges, a pair of standardised internal 1/2 bridge completion networks (HB1 and HB2) are provided which are used to complete external 1/2 bridges using jumper links (one per channel).
For 1/4 bridges, a turret lug mounted 120Ω or 350Ω completion resistor RC (a & b), is used in conjunction with the standard 1/2 bridge completion. Hence only one precision resistor per channel is needed to complete a 1/4 bridge.
Manual balance is provided by front panel multiturn ‘Balance’ potentiometers and associated series resistors (which are selected using the jumper area “shunt bal”).

1.3 Bridge Calibration system

A shunt calibration for bridges is included. This operates through an opto coupler and switching is carried out by VMOS FET transistors. Resistors RCal (a & b) are turret lug mounted, and are selected onto the ‘p’ inputs of the pre-amplifiers. Calibration polarity causes the output to move in a positive direction.

1.4 Pre-Amplifiers

The instrumentation pre-amplifiers are integrated circuit type featuring low drift and low noise coupled with high accuracy and excellent common mode rejection. They have in built protection against overvoltage and are provided with an input filter to limit high frequency interference. The pre-amplifier has gain steps of x1, x10, x100, and x1000 selected via jumper links.

1.5 Low Pass Filter

The pre-amplifiers are followed by low pass filters. The filters are 3rd order Butterworth Sallen-Key designs whose frequency setting is programmed by plug in resistor networks RP1 for channel a and RP2 for channel b. The filters may be used for noise reduction, or as simple alias protection where the signal is to be A-D converted. A jumper area allows the filter to be bypassed for maximum bandwidth.

1.6 Output Buffer Amplifiers

The output buffer amplifiers provide additional gain settings x1, x2 and x5. Coupled with the pre-amplifier gain settings previously described, they enable any gain from x1 to x 5000 in a 1, 2, 5 sequence. Vernier gain potentiometers are included. These multi-turn controls gives an additional x2.5 maximum and enable coverage between the calibrated gain steps.

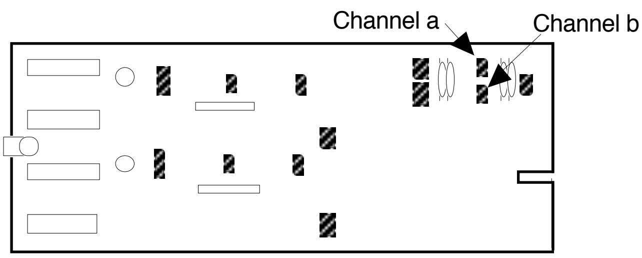
2 Configuration of the Module

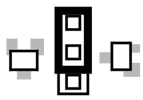
Refer to 'Component Idents' drawing 1080PC for additional configuration information. Note that the circuit board is silk screen idented to aid component location.

2.1 Bridge Configuration

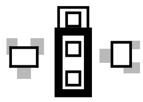
The module will operate in full or fractional bridge configuration. It will also operate as an amplifier only. Wiring should generally be completed in screened cable, with the screen connected to chassis as described.

There is a jumper area for each channel near the rear of the module which must be set up to select full bridge or fractional (i.e. 1/4 or 1/2 bridge). Refer to the drawing in the appendix (1080PC) to identify these jumper areas. In the diagrams below these jumper positions are referred to as **'a'** and **'b'** (not to be confused with Channel a and Channel b).



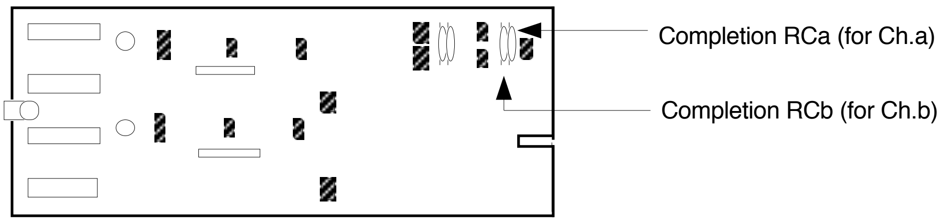


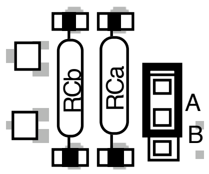
Full Bridge (position 'a')



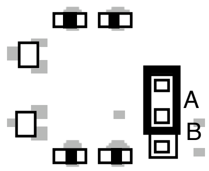
Fractional Bridge 1/4 and 1/2 (position 'b')

In addition there is a completion resistor position for each channel also located near the rear of the module.
For 1/4 bridge operation a special resistor (very high precision) must be fitted to the RCa position (for channel a) or to the RCb position (for channel b). **Note that for all other configurations this resistor must be removed.**





1/4 Bridge Configuration only

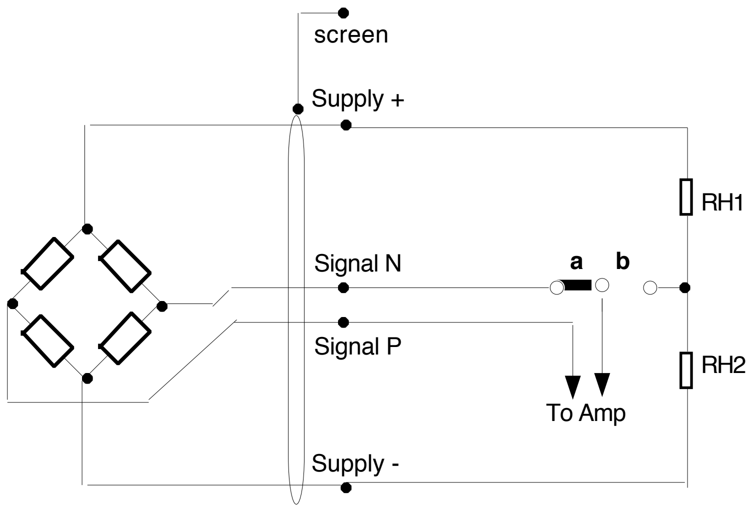


All other Bridge Configurations

Also shown above is a selector for Bridge Voltage, also sometimes called excitation voltage or transducer supply.

In the position **'A'** shown above it will be +5V or +2.5V depending upon a jumper setting in the system power supply.
In the **'B'** position it will be +10V or +7.5V (again, depending upon the system power supply jumper setting).

2.1.1 Full Bridge Connection



Fit Jumper Links **a** (1 per channel)

Select Link A for 5V (5V or 2.5V with MMx)
Suitable for 120Ω or higher.

Select Link B for 10V (10V or 7.5V with MMx)
Suitable for 350Ω or higher.

Connections shown apply to either channel. The full bridge connection requires no completion resistors either internal or external to the amplifier

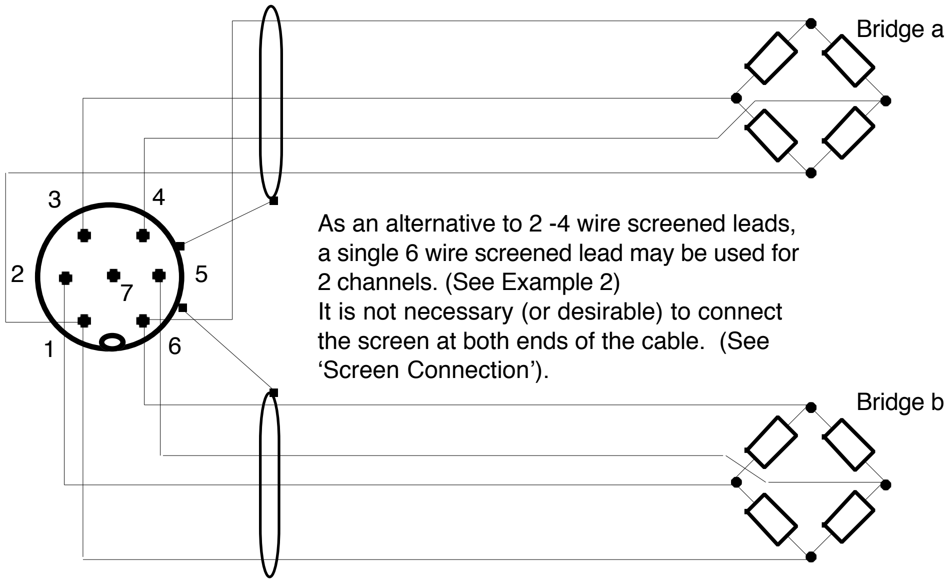
Either 4 wire screened lead (1 per channel) or a 6 wire screened lead may be used for 2 channels.
The bridges may be wired with 4 wire screened lead with one cable per channel. This will necessitate the fitment of two screened leads within the one connector; this is feasible providing that the cable overall diameter is small enough (less than 3.5 mm overall diameter per cable) - the rubber connector outlet boot may need to be trimmed marginally to allow passage for the two cables.
As well as full bridge strain gauge configurations, this configuration suits many proprietary transducers such as pressure transducers, piezo-resistive accelerometers and load cells, many of which are based on a full bridge format.

2.1.2 Recommended Connection for Full bridge

Example 1

7 pin Tuchel connector
(view into chassis mounted plug)

Pin 1	Supply -	
2	Signal Nb	
3	Signal Na	
4	Signal Pa	
5	Signal Pb	
6	Supply +	
7	Screen	

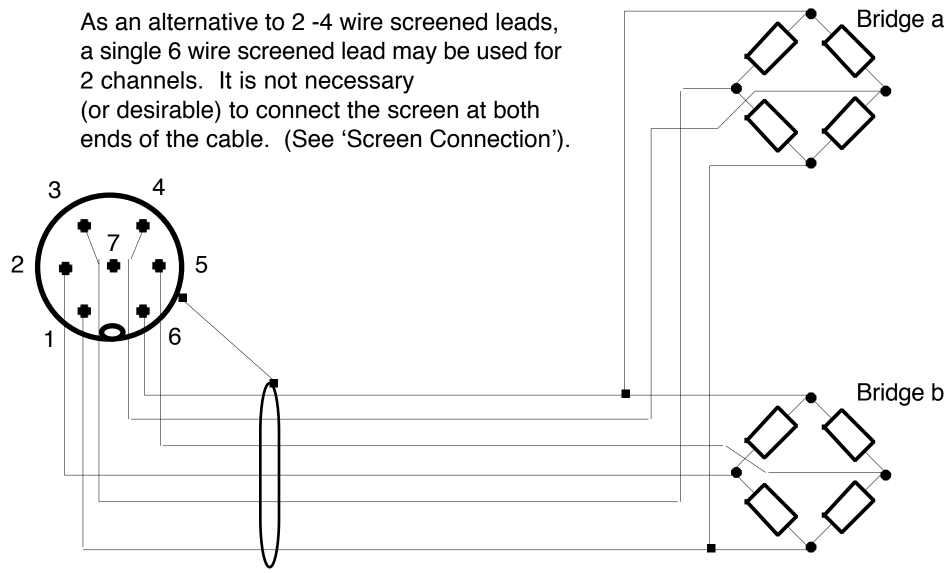


2.1.3 Recommended Connection for Full bridge

Example 2

7 pin Tuchel connector
(view into chassis mounted plug)

Pin 1	Supply -	
2	Signal Nb	
3	Signal Na	
4	Signal Pa	
5	Signal Pb	
6	Supply +	
7	Screen	

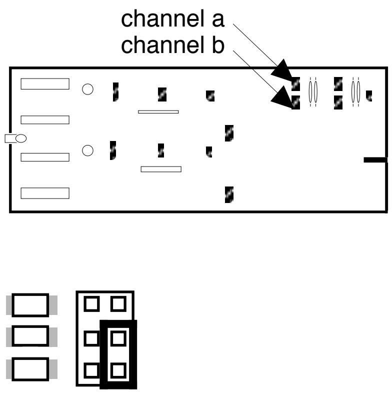


2.1.4 Use as a Voltage Amplifier

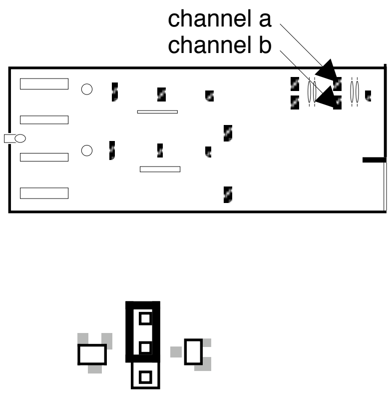
The FE-366-TA incorporates high quality pre-amplifier integrated circuits. These are low noise, low offset and drift, and have high common mode rejection. Use of the amplifiers for the amplification of voltage sources is quite straightforward. The amplifier gain extends from x1 to >x10000 and voltages from ±10V to <1 mV may be applied.

Configuration is as for full bridge, with jumper links in position to complete the signal N connections. Connect the voltage to be amplified across pins 3 and 4 for channel a, or pins 5 and 2 for channel b.

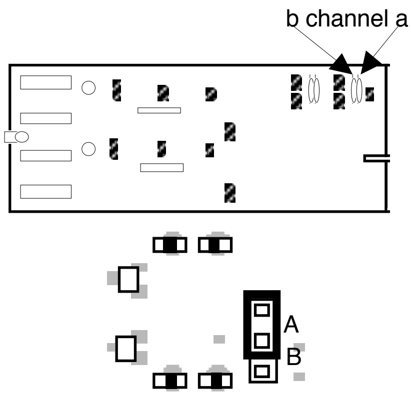
In addition the shunt balance resistor which is used to correct bridge imbalance should be disconnected as shown below.



Shunt Balance disconnected for use as a voltage amplifier.



Jumper position **'a'** completes signal N connections for use as a voltage amplifier.



Completion resistors removed for use as a voltage amplifier.

2.1.4.1 Common Mode Voltage

It is necessary to ensure that the average voltage of the signal source with respect to mains earth remains inside the common mode limit of the pre-amplifiers; this is ±10V with respect to mains earth. Any signal source which has one end connected to mains earth will obviously satisfy this requirement, and in this case only the N and P connections need be made.

Voltages which are completely floating are more difficult to quantify, and if no connection of the source and amplifier exists at all via mains earth, such as for isolated systems or battery operated sources, then it is permissible to join the Signal N connection to the Screen (common) connection to produce a 2 wire connection. Alternatively , the source may have a body connection of it's own, and if this is not already connected to mains earth, then the screen connection may be made here.

The amplifier is quite forgiving as regards input connection and there will often be several ways to attain an acceptable connection. The amplifier is well protected against overload, and can be applied with confidence as long as inputs are likely to be below ±25V.

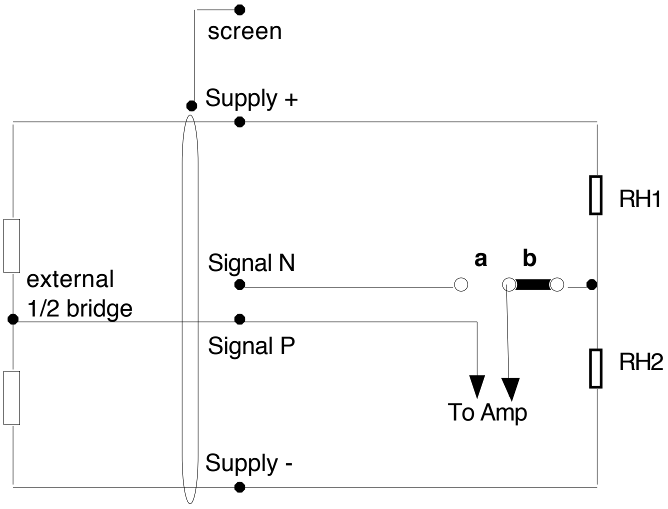
2.1.4.2 Balance resistors and Calibration resistors

Shunt balance resistors are set using a jumper in the "shunt bal" jumper area. This jumper should be removed for application as a voltage amplifier.

Calibration resistors RCALa and b (see page 15) are not normally used for voltage sources. Be sure to remove any value in these positions.

Finally, always use screened cable for the inputs; if only N and P connections are required, then the screen is made off only at the 7 pin Tuchel end.

2.1.5 Half Bridge Connection



Fit Jumper Links **b** (1 per channel)

Select Link A for 5V (5V or 2.5V with MMx)
Suitable for 120Ω or higher.

Select Link B for 10V (10V or 7.5V with MMx)
Suitable for 350Ω or higher.

Connections shown apply to either channel.

The amplifier has a built in 1/2 bridge (RH1 and RH2) for each channel; this is selected by jumper links b. No additional resistors are needed to complete a half bridge.
3 wires in a screen lead are required for each channel (Example 1). A 6 wire screened lead may be used for 2 channels in most applications. If the two channels for a particular card are located close together, a 4 wire screen lead may be used as shown in Example 2.
Note that in the case of half bridge connections, only the 'P' input is taken out to the gauges; the 'N' input is completed internally. This means that the input wiring is unavoidably arranged in the form of a loop, and electrical interference or 'pick up' in this loop is possible. This is a known problem with all half bridge connections which may be minimised as follows:-

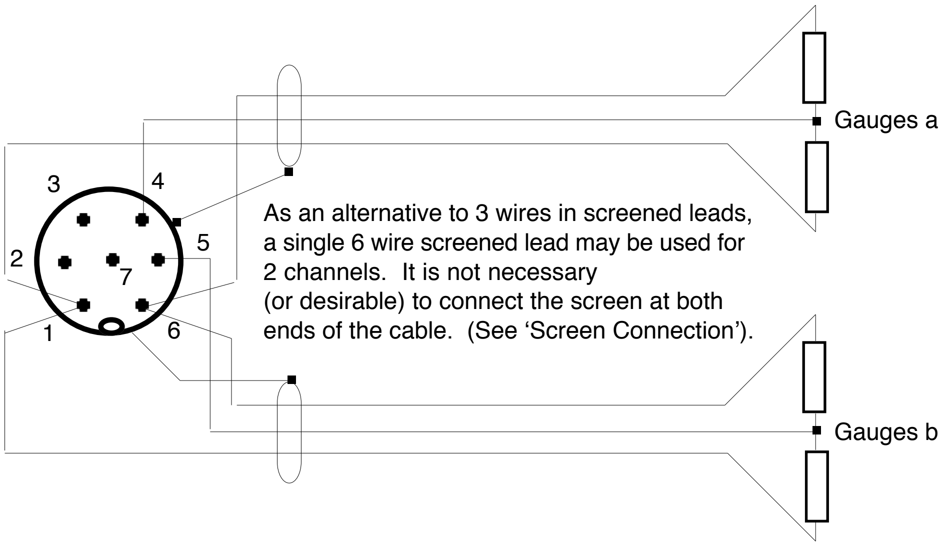
i) Keep lead lengths as short as practicable.
ii) Use screened cable to minimise electrostatic pick up.
iii) Keep cable runs clear of motors and transformers etc., which may produce magnetic fields.
iv) Use a filter setting below 50 Hz if the measurement will tolerate it.
v) If all else fails, it is permissible to set the amplifier into full bridge mode and complete the bridge closer to the specimen (use 2 x 3 ppm 0.1% resistors which match the gauges). See 'Full Bridge Connection' for details.

2.1.6 Recommended Connection for 1/2 bridge

Example 1

7 pin Tuchel connector
(view into chassis mounted plug)

Pin 1	Supply -
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +
7	Screen

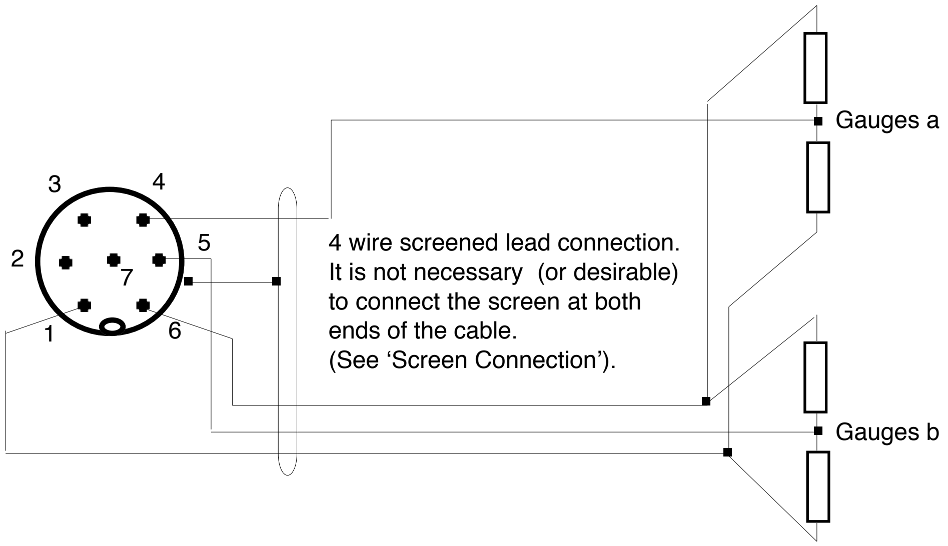


2.1.7 Recommended Connection for 1/2 bridge

Example 2

7 pin Tuchel connector
(view into chassis mounted plug)

Pin 1	Supply -
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +
7	Screen



2.1.8 Screen Connection (applicable to all bridge configurations)

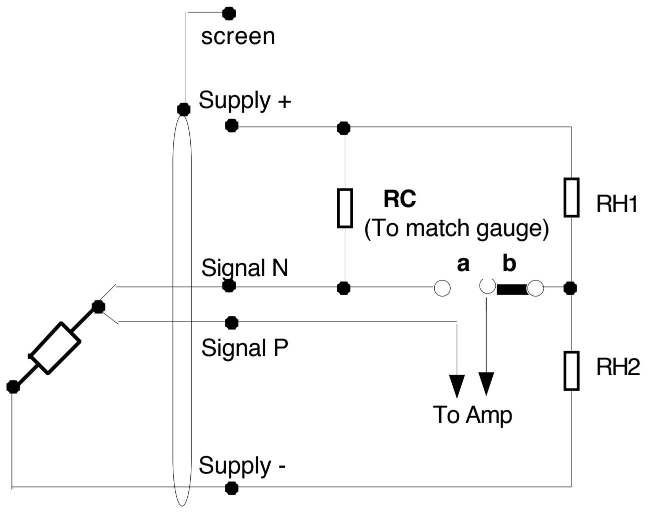
The screen(s) of the cables(s) should be connected to the body of the Tuchel connector for which an internal solder tag is provided inside each connector. This connects the screens directly to chassis and is the favoured connection for best EMC performance. Alternatively, the screens may be connected to pin 7 'screen'; this is the common 0 V of the power supplies and amplifiers and is connected to chassis by **Link E** in the amplifier power supply, FE-800-PSU. This gives the option of disconnecting the screens from the chassis should the need arise (for instance if a connection exists on the other end of the screen which is causing earth loop interference).

In the case of mains powered systems, Link E must only be removed if an alternative connection to mains earth for common is provided. If this practice is not adhered to, a **safety hazard** exists.

Reasons for removal of Link E mainly involve systems which may have multiple earth connections. Best practice calls for only one earth connection to a collection of measuring instruments - although in most installations having multiple earths will cause no problems whatsoever. FYLDE recommends that Link E be maintained unless it can be proved that an earth loop is generating interference.

NOTE : For DC powered systems such as the FE-MM8, the chassis is isolated from the DC supply and the recommended connection of the screen of the input cable is to chassis via the Tuchel connector solder tag.

2.1.9 Quarter Bridge Connection



Fit completion resistor **RC** (1 per channel)

Fit Jumper Links **b** (1 per channel)

Select Link A for 5V (5V or 2.5V with MMx)
Suitable for 120Ω or higher.

Select Link B for 10V (10V or 7.5V with MMx)
Suitable for 350Ω or higher.

Connections shown apply to either channel.

The amplifier has a built in 1/2 bridge (RH1 and RH2) for each channel; this is selected by jumper links b. Only one resistor (RC) is needed per channel to complete a quarter bridge and this should be soldered to the turret lugs provided. The value of RC should be equal to the gauge (generally 120Ω or 350Ω). Miniature high stability, high accuracy resistors are available from FYLDE.

Note that the "SIG N " connection is reused to bring back the bridge apex thus maintaining bridge balance and temperature stability with long cables. Signal N and signal P connections should be joined at the gauge or as close as practical to it. 3 wires in a screen lead are required for each channel. A 6 wire screened lead may be used for 2 channels in most applications. For short cable lengths or large signals, a two wire connection may be substituted for the 3 wires. The polarity of the bridge and amplifier is arranged so that in 1/4 bridge connection, the output voltage will be positive for the gauge value increasing, i.e., for tension, in line with standard practice.

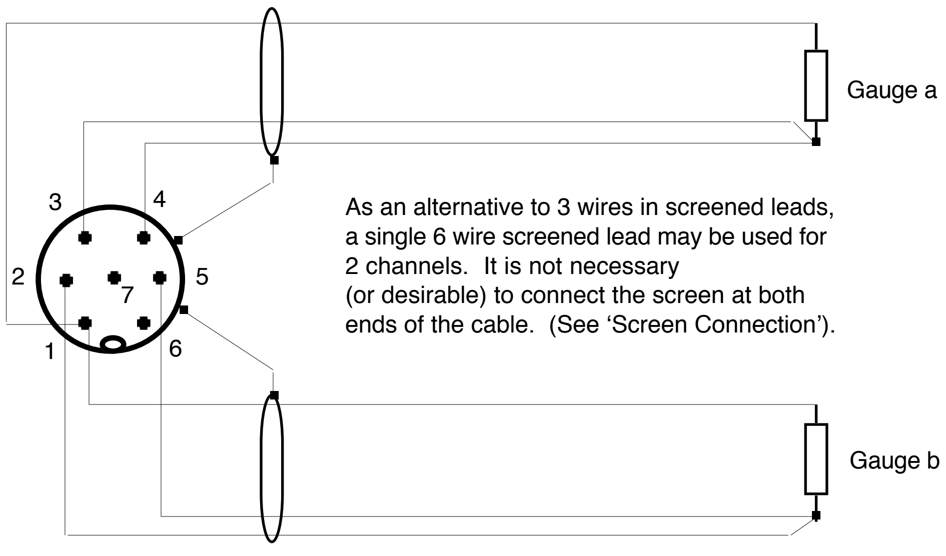
Note: Due to localised loading of the bridge supply on the amplifier card, it is recommended that both gauges (a and b) be connected before setting the amplifier zero, as the balance may alter slightly as the second gauge is added. This effect is more marked for 120Ω gauges. It is also important to keep edge connectors clean. Avoid touching the gold edge connectors with the fingers. Clean the connectors if moving the cards within their slots produces large output changes. FYLDE recommends FE10 cleaning fluid for the edge connectors.

Important : Be sure to remove any RC value before resuming 1/2 or Full Bridge working.

2.1.10 Recommended Connection for 1/4 bridge

7 pin Tuchel connector
(view into chassis mounted plug)

Pin	
1	Supply -
2	Signal Nb
3	Signal Na
4	Signal Pa
5	Signal Pb
6	Supply +
7	Screen

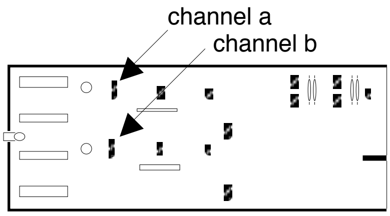


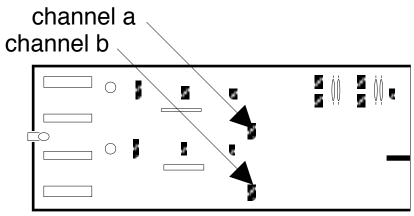
As an alternative to 3 wires in screened leads, a single 6 wire screened lead may be used for 2 channels. It is not necessary (or desirable) to connect the screen at both ends of the cable. (See 'Screen Connection').

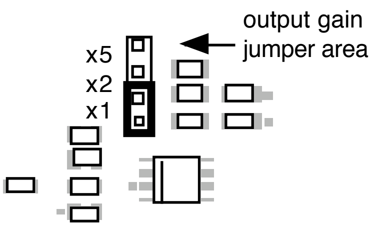
2.2 Setting the Gain

The pre-amplifier has Input Gain steps of x1, x10, x100, and x1000 selected via jumper links as shown below right. The arrangement is identical for channels ‘a’ and ‘b’.

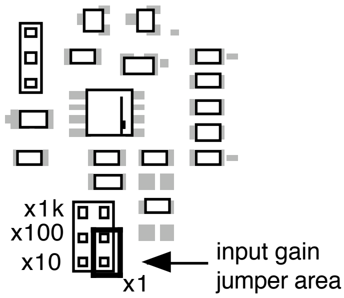
The output buffer amplifiers provide additional Output Gain settings; these are chosen to be x1, x2 and x5. Coupled with the pre-amplifier gain settings, they enable any gain from x1 to x 5000 in a 1, 2, 5 sequence to be set.
Vernier gain potentiometers are included on the front card edge. These multi-turn controls gives an additional x2.5 maximum and enable coverage between the calibrated gain steps.



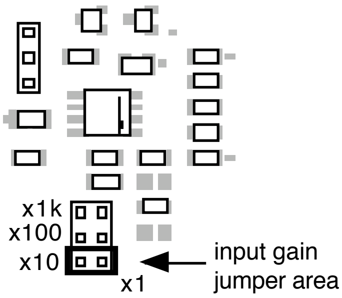




x1 gain setting shown above

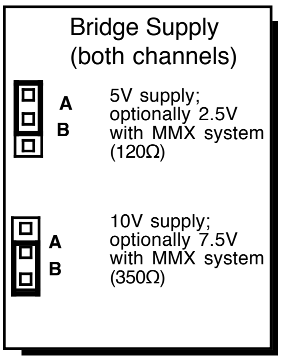


x1 gain setting shown above



x10 gain setting shown above

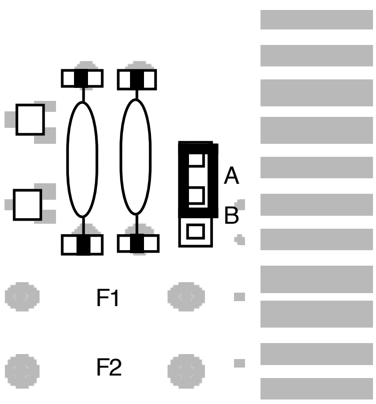
2.3 Setting the Bridge Voltage



The bridge voltage may be set to either 5V or 10V (±5V) for any card as required. When operating in the FE-MM8 or MM16 chassis, an extra link on the FE-810-BPSDC power supply enables 2.5V and 7.5V to be obtained in addition.

The choice of which voltage to use is made by reference to the value of the gauges or transducer.
For 120Ω gauges choose 2.5V (if available) or 5V, but 350Ω types may use either 10V or 5V (10V will yield the greater sensitivity). For transducers with higher than 350Ω resistance, select 10V.

The MA32 system power supply is capable of powering 32 bridges of either value and in any configuration. The MM8 and MM16 systems have ample power for any load combination.



In the case of 40 channel systems, power is sufficient for :-
i) 40 off 350Ω 1/4, 1/2 or full bridges @ 10V.
ii) *40 off 120Ω 1/4 or 1/2 bridges @ 5V.
iii) Any load up to a maximum of 1.2A @ 10 V (1.6 A @ 5 V).

*40 off 120Ω would normally require 1.67A, but internal low power half bridges reduce current to within limit.

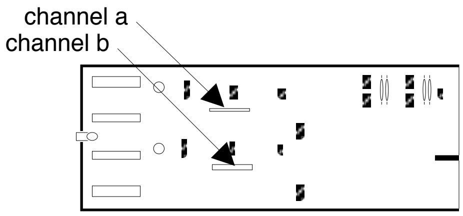
Important: Optional fuses F1 and F2 protect the other modules’ channels in case of short circuit. **Always** switch off before adjustments to input connections are made. Spare fuses are available from FYLDE. Power supply overload is signified by a flashing power led.

A complete drawing of the FE-366-TA card is included in the appendix of this handbook.

2.4 The Low Pass Filter

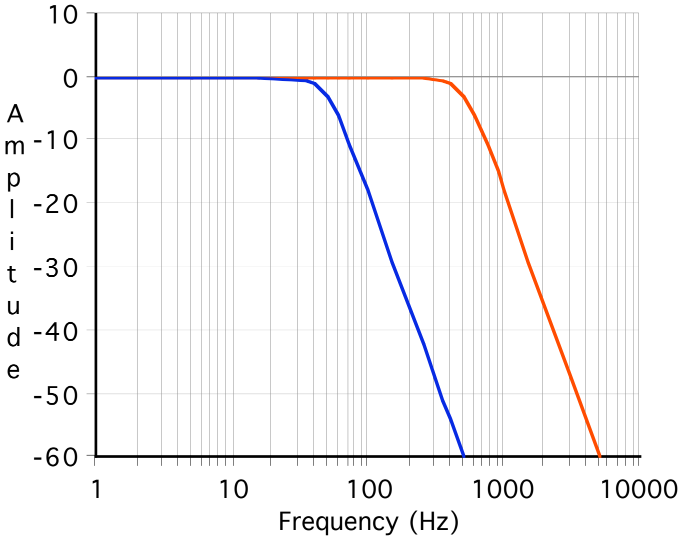
The low pass filter is a 3 pole (-18 dB / octave) Sallen Key design with Butterworth response. The cut off frequency may be chosen to be from 4.7 Hz (-3 dB) to 4.7 kHz (-3 dB). Resistor pack RP1 programmes the filter over this range. Note that the pre-amplifier bandwidth on gain x1000 is approximately 12 kHz and will limit the upper frequency response with filter out.

If higher bandwidth is desired, set filter out and choose a pre-amplifier gain between x1 and x100. Output gain of x5 enables x500 overall, and a further x2.5 uncalibrated gain may be applied with the front card edge x2.5 gain vernier control.

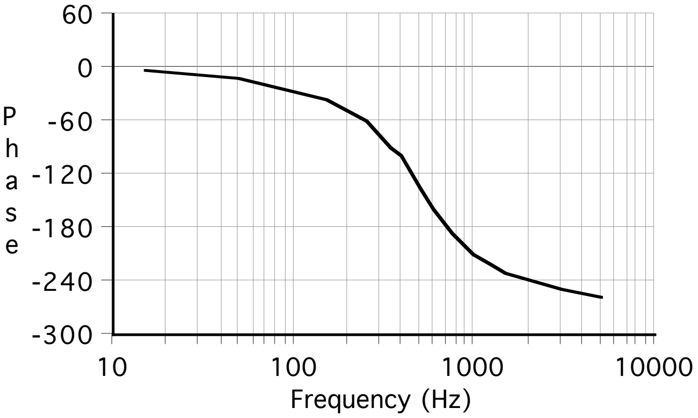


Cut-off (Fc)	RP1 value	Gains
4.7Hz	1MΩ	1 - 5000
47Hz	100kΩ	1 - 5000
470Hz	10kΩ	1 - 5000
4.7kHz	1kΩ	1 - 5000

FE-366-TA
The factory fitted value for RP1 is 10kΩ (470Hz -3dB). Alternative filter resistor packs are available from FYLDE for a nominal charge.



Frequency response plots for Fc 470Hz and Fc 47Hz.



Phase response plot for Fc 470Hz Butterworth response.
Channel to channel Phase match is within ±1° @ 0.5Fc and ±2° @ 0.75Fc.

2.5 Connecting the Output

The amplifier outputs are ±10 V full scale with a capability of ±2 mA.

The FE-MA32/40 chassis is fitted with a 50 way output connector carrying 40 channels of single ended output signals, and the FE-MM8 & MM16 chassis are fitted with 15 way output connectors carrying 8 channels of single ended output signals. The FE-MM16 is fitted with 2 connectors for 16 channels. Refer to the “System Chassis” section of this handbook for details of these connectors. Note that BNC breakout boxes (type FE-MAC40C and MAC8C) are available as an option.

2.6 Calibration

This amplifier provides shunt calibration, simulating a bridge output by means of shunting one arm of a bridge by a resistor, thus modifying the resistance of the shunted bridge arm.

A shunt resistor position is provided for each channel for calibration. These resistors are known as RCALa and RCALb. Refer to drawing 1080PC in the appendix of this handbook for the location of these resistors. Note that turret fittings are used to mount these components in order to facilitate easier change of value if required.
The polarity is arranged such that the output moves positive when the calibration is invoked. The calibration level is superimposed on the existing output level.

2.6.1 Selection of Calibration Resistors (RCALa or b)

The electrical output of the bridge, V, for a given output in microstrains can be obtained by applying the following formulae:-

for 4 active gauges, $\partial v = \dfrac{\text{Output in microstrains x Bridge Voltage x Gauge Factor}}{1000}$ millivolts

for 2 active gauges, ∂v = 1/2 the above

for 1 active gauge , ∂v = 1/4 the above

To obtain the required calibration resistor value (in ohms) for a given output, apply the following formulae:

$$\partial v = \frac{Rd/2}{Rcal + Rd/2} \cdot \frac{V}{2}$$

$$\text{therefore, } Rcal = \frac{V}{\partial v} \cdot \frac{Rd}{4} - \frac{Rd}{2} = \frac{10^6}{\partial l/L.GF} \cdot \frac{Rd}{4} - \frac{Rd}{2}$$

where with a given Rcal the output ∂v is the same for 1, 2, or 4 active arm bridges.

For a Bridge combination of:	1 active arm	2 active arms	4 active arms
To simulate a given mV output (∂v), Rcal =	$\left[\frac{V}{\partial v} \cdot \frac{Rd}{4}\right] - \frac{Rd}{2}$	$\left[\frac{V}{\partial v} \cdot \frac{Rd}{4}\right] - \frac{Rd}{2}$	$\left[\frac{V}{\partial v} \cdot \frac{Rd}{4}\right] - \frac{Rd}{2}$
To simulate a mechanical strain ($\partial l/L$) Rcal =	$\left[\frac{10^6}{\partial l/L.GF} \cdot Rd\right] - \frac{Rd}{2}$	$\left[\frac{10^6}{\partial l/L.GF} \cdot \frac{Rd}{2}\right] - \frac{Rd}{2}$	$\left[\frac{10^6}{\partial l/L.GF} \cdot \frac{Rd}{4}\right] - \frac{Rd}{2}$
To simulate a given output in μstrains Rcal ≈	$\frac{Rd \times 10^6}{\text{microstrains x GF}}$	$\frac{Rd \times 10^6}{\text{2 x microstrains x GF}}$	$\frac{Rd \times 10^6}{\text{4 x microstrains x GF}}$
To simulate a given % strain, for 0.1% Rcal≈	$\frac{1000Rd}{GF}$	$\frac{1000Rd}{2\,GF}$	$\frac{1000Rd}{4\,GF}$

where: -	V	= Bridge supply voltage
	Rcal	= Required calibration resistor (in ohms)
	∂v	= Voltage developed by Rcal
	Rd	= Dummy arm (bridge completion RC) or Gauge resistance (in ohms)
	∂l/L	= Output in microstrains
	GF	= Gauge Factor

Note that the above formulae take no account of long cable effects, which can introduce calibration errors.

2.6.2 Calibration Resistor Type

The calibration resistor should be a good quality metal film resistor, with 1% or better tolerance. The calculated value should be carefully soldered into the position provided (marked RCAL) adjacent to the jumper link area.

To avoid possible damage to the FET calibration switches, it is essential to use good static control methods when soldering in any calibration resistor.

Calibration resistors may be chosen from the E96 range which will enable the value required to be closely approximated.

2.6.3 Example Calibration Calculation

To calculate the required resistor to simulate 1000μStrains for a 120Ω 1/4 active bridge with gauge factor of 2.2 :-

$$Rcal = \frac{Rd \times 10^6}{\text{microstrains} \times GF}$$

$$Rcal = 120{,}000 / 1000 \times 2.2 \quad k\Omega$$

$$\mathbf{Rcal = \underline{\underline{54.55\ k\Omega}}}$$

3 Operation

Before operating the system, it is advisable to study the previous pages referring to Bridge Voltage, Gain Setting etc.

3.1 Switching On

3.1.1 FE-MA32 or FE-MA40

The system power switch is located on the rear panel. Two mains voltage settings are available; be sure to check that the most suitable setting for your available supply is selected :-

‘120’ 103 - 127 V AC 50/60 Hz 50 VA max. **‘240’ 207 - 253 V AC 50/60 Hz 50 VA max.**

Fusing is 0.63 A(T) located in the pull out tray which forms part of the IEC mains connector (a spare is included).

On switch on, the green power led should illuminate. If this led flashes, this is indicative of power supply overload.

Note: If this should occur, check transducer resistances and card voltage selections are within stated limits. (See 2.3 Setting the Bridge Voltage).
If the load and the card voltage selections prove to be correct, input connectors should be removed in stages in order to isolate the fault.

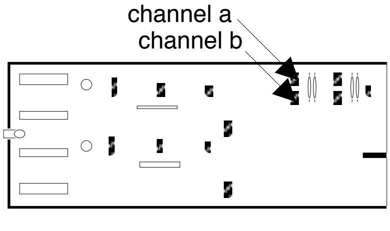
3.1.2 FE-MM4, FE-MM8, FE-MM16 & FE-MM40

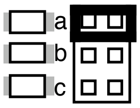
Apply a DC voltage of between 10V and 36V to the power inlet (see “System Chassis” section). An internal fuse is fitted and protection is provided for reverse supply. An inline mains to DC supply is available as an option.
On switch on, the green power led should illuminate. If the led flashes, this is indicative of power supply overload (see note above).

3.2 Balancing the Bridge

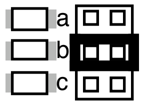
3.2.1 Balance Resistor

With power on and inputs connected, the outputs of the modules will assume various offsets and it should be possible to balance these to zero by use of the front card edge ‘Balance’ controls for each channel.
The balance resistor, which is controlled by the front panel control ‘Balance’ , may be chosen to be 100 kΩ, 22kΩ or 5.6 kΩ using the “shunt bal” jumper area. Note that these jumpers are labelled a,b,c, (not to be confused with channels a and b)

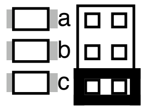




100 kΩ setting



22 kΩ setting



5.6 kΩ setting

The factory set position of this jumper is 22 kΩ. This value will correct approximately 2% unbalance in a 350Ω gauge and approximately 0.6% unbalance in a 120Ω gauge.
RBAL may be reduced in value where a balance cannot be obtained, but avoid making the balance resistor unnecessarily low, as the potentiometer may become unduly coarse in operation.

For systems with **Auto Zero**, it is still necessary to achieve approximate balance manually, at least for initial set up; after which, operation of the ‘AZ’ will zero all channels with minimum effort.

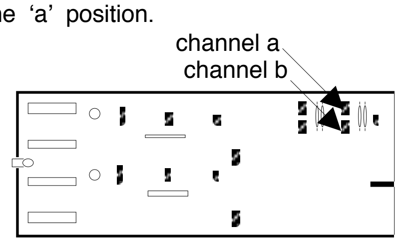
3.2.2 Problems in Balancing the Bridge

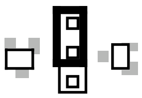
If a zero cannot be obtained by operation of the balance control, it is advisable to reduce the gain in order to ensure that the output is less than ±10 V. Operating the balance control then should enable the output to be moved positive and negative. By this means, the user should attempt to make the output zero. If this is possible with a low gain, the gain may be gradually increased to the desired setting (please note that it necessary to switch off and remove the module for each change).

If the output will move in response to the balance control, but a zero cannot be obtained, the balance resistor may be lowered in value (see Balance Resistor).

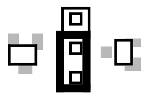
For modules which exhibit high offset even on low gains, and particularly if they do not respond at all to the balance control, suspect the connection or configuration of the bridge.

i) If the input is a full bridge, check that the internal half bridge is not selected, ie check that the fractional bridge link is in the 'a' position.





Full Bridge (position 'a')



Fractional Bridge (position 'b')

ii) If the input is a full bridge, check that any value of completion resistor RC which may have been fitted previously has been removed.

iii) If the input is a 1/2 bridge, check that the internal fractional bridge link is in the 'b' position.

iv) If the input is a 1/4 bridge, check that the internal fractional bridge link is in the 'b' position and that the *appropriate value of RC is fitted for that channel.

* should equal gauge or transducer resistance value.

If the fault persists, it is often worth examining such bridges with a test meter to check that the correct resistance values are present, and that wiring is correct.

3.3 Termination of Unused Inputs

Generally, it is not necessary to terminate unused inputs. However in the case of fractional bridge configuration where the internal 1/2 bridges are employed, if only one channel on a card is connected it is advisable to leave the unconnected channel with its 1/2 bridge link set to selection 'a' , i.e., full bridge. This will prevent the limit condition (inevitable at the input of an unconnected amplifier) interfering with the channel in use.

3.4 Operation with Proprietary Transducers

The FE-366-TA is designed to operate with most transducers which have bridge configuration. These include Pressure Transducers, Load Cells, Piezo-Resistive Accelerometers and others.

Output from such transducers is usually given as mV / V / mechanical unit such as 0.3 mV / V / kg or 1 mV / V / bar.

Example 0.3 mV / V / kg

If the transducer is 350Ω full bridge, with energising voltage of 10 V, then the output is 3 mV / kg.

For a full scale of 50 kg, the output is 150 mV.

Set the bridge voltage to 10 V

Pre-amplifier gain to x 10

Output stage gain to x5

Configure for full bridge.

Zero the output using the 'Balance' control with no load.

The output of the amplifier will be **7.5 V** for 50 kg.

3.5 Calibration Resistor

4 active arms

To simulate a given output in mV

$$Rcal = \left[\frac{V}{\partial v} \cdot \frac{Rd}{4}\right] - \frac{Rd}{2}$$

$$Rcal = \frac{10 \times 350}{0.15 \times 4} - \frac{350}{2}$$

$$\mathbf{Rcal = \underline{\underline{5.658\ k\Omega}}}$$

It is not essential to fit the calibration resistor, but this value will simulate 50 kg for the example given. When activated, the output of the amplifier will be 7.5 V, (± an allowance for gain, bridge voltage and resistor accuracies). If desired, the vernier gain (x2.5 control) may now be activated to raise the output to 10 V exactly.

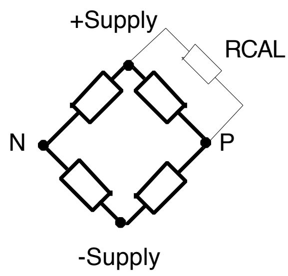
3.6 Applying the Calibration

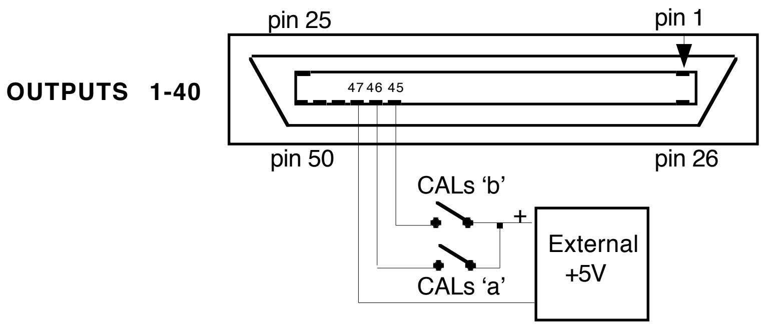
This amplifier provides shunt calibration, simulating a bridge output by means of shunting one arm of a bridge by a resistor, thus modifying the resistance of the shunted bridge arm.

A shunt resistor position is provided for each channel for calibration. These resistors are known as RCALa and RCALb. Refer to drawing 1080PC in the appendix of this handbook for the location of these resistors. Note that turret fittings are used to mount these components in order to facilitate easier change of value if required.
The polarity is arranged such that the output moves positive when the calibration is invoked. The calibration level is superimposed on the existing output level.

The calibration level is applied via opto coupled FET switches.

3.6.1 Applying the Calibration - FE-MA32/40 System Chassis





Calibration command is arranged in two groups, a and b. To invoke calibration for all ‘a’ channels (odd numbers 1 - 39), apply a voltage level of between +3.5 volts and +12 volts to pin 46, with 0 V on pin 47, of the 50 way **OUTPUTS 1-40** connector. For all ‘b’ channels (even numbers 2-40) pin 45 is used, again with pin 47 as 0 V.

Channels	+V	0V
'a' (Odd 1-39)	Pin 46	Pin 47
'b' (Even 2-40)	Pin 45	Pin 47

The current required is approximately 0.4 mA (@ 5 V) per channel, and therefore around 6 mA is drawn from the external voltage source for each group ‘a’ or ‘b’. All channels may be calibrated simultaneously if required by applying the voltage to pins 45 and 46. Note that complete isolation between the amplifier analogue common and the calibration circuits is provided.

3.6.2 Applying the Calibration - FE-MM4

To invoke calibration for all channels, apply a voltage level of between +3.5 volts and +12 volts to pin 9, with 0 V on pin 14, of the 15 way rear panel connector. Note that complete isolation between the amplifier analogue common and the calibration circuits is provided.

The current required is approximately 0.4 mA (@ 5 V) per channel, and therefore with the maximum of two modules fitted around 1.6 mA is drawn from the external voltage source. Alternatively pin 10 (+12 V) and pin 11 (0 V) may be used to apply the voltage level using a switch. (Connect pin 14 to pin 11 directly, and connect pin 10 to pin 9 through the switch.)

3.6.3 Applying the Calibration - FE-MM8

If the system has no USB interface module (FE-356-USB), then to invoke calibration for all channels, apply a voltage level of between +3.5 volts and +12 volts to pin 9, with 0 V on pin 14, of the 15 way connector. Note that complete isolation between the amplifier analogue common and the calibration circuits is provided.

The current required is approximately 0.4 mA (@ 5 V) per channel, and therefore with the maximum of four modules fitted around 3 mA is drawn from the external voltage source. Alternatively pin 10 (+12 V) and pin 11 (0 V) may be used to apply the voltage level using a switch. (Connect pin 14 to pin 11 directly, and connect pin 10 to pin 9 through the switch.)

With the USB interface module fitted, the calibration control of the FE-366-TA cannot be driven externally, but the USB software may be used to turn the calibration on and off. (Refer to the information provided with the USB software.)

3.6.4 Applying the Calibration - FE-MM16

To invoke calibration for all channels, apply a voltage level of between +3.5 volts and +12 volts to pin 9, with 0 V on pin 14, of the 15 way “OUTPUTS 9 to 16” connector. Note that complete isolation between the amplifier analogue common and the calibration circuits is provided.

The current required is approximately 0.4 mA (@ 5 V) per channel, and therefore with the maximum of eight modules fitted around 6 mA is drawn from the external voltage source. Alternatively pin 10 (+12 V) and pin 11 (0 V) may be used to apply the voltage level using a switch.(referring to the connector “OUTPUTS 9 to 16”, connect pin 14 to pin 11 directly, and connect pin 10 to pin 9 through the switch.)

With the USB interface module fitted, the calibration of the FE-MM16 can be driven externally because the USB interface for the FE-MM16 has opto-isolated digital outputs which do not override the external calibration without external pull up resistors. For the FE-MM16, driving the calibration using software requires external components to power the opto-isolated open collector outputs. For more information on configuring the FE-MM16 to drive the calibration using USB software, see the FE-MM16 chassis section of the handbook.

3.6.5 Applying Calibration - FE-MM40

If the system has no FE-810-SEL module fitted, the internal digital outputs which drive the calibration are available to be driven. Even channels (2,4,6 etc. through to 40) can be selected for calibration using pin 47 of the output connector at between +3.5 volts and +12 volts, with 0V on pin 50. For the odd channels (1,3,5 etc. through to 39) use pin 46 with 0V on pin 50.

The current required is approximately 0.4 mA (@ 5 V) per channel, and therefore with the maximum of twenty modules fitted around 16 mA is drawn from the external voltage source when all 40 channels are selected for calibration simultaneously.

With the FE-810-SEL module fitted, the calibration control of the FE-366-TA cannot be driven externally, but the USB software may be used to turn the calibration on and off. (Refer to the information provided with the USB software.)

4 Technical Notes

4.1 Accuracy of Shunt Calibration

The accuracy of shunt calibrations is affected by line resistance (RL). In general, the user should aim to keep connections out to the bridge as short as possible and of sufficient gauge to keep resistance as low as possible.

$$\partial v \text{, for } Rcal >> Rd \quad = VRd / 4Rcal$$

....is the formula for the output of a bridge due to Rcal with no line resistance.

Introducing line resistance RL, the formula becomes:-

$$\partial v = V(Rd+2RL) / 4Rcal$$

The apparent gauge resistance to the shunt cal resistor is increased by 2RL, and so the output developed by the calibration resistor will be increased by the ratio (Rd+2RL) / Rd.
The bridge voltage, and thus output of the bridge due to physical load, however, decreases due to line resistance by the same factor, necessitating a further increase in Rcal as the sending voltage (used by Rcal) is still at its original level.

E.g. In order to simulate say 500 μStrains mechanical for a 350Ω, full bridge where the Gauge Factor is 2, with line resistance of 3Ω:-

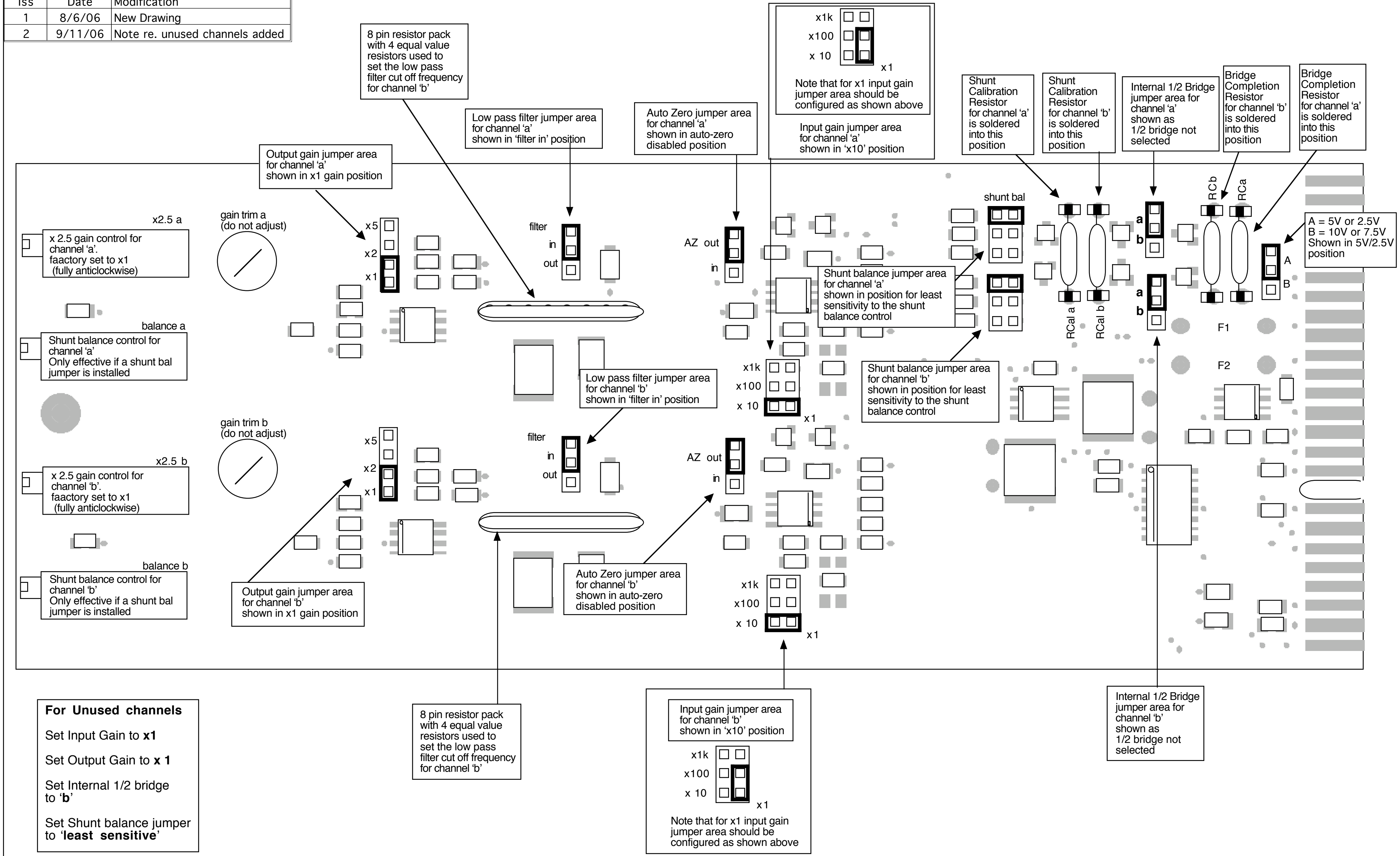
$Rcal = 350 \times 10^6 / 4 \times 500 \times 2$ so $Rcal = 87.5\ k\Omega$

Allowing for line resistance of 3Ω in each direction, now $Rcal = (356 / 350)^2 \times 87.5\ k\Omega = \underline{90.5\ k\Omega}$

This resistor, mounted in the amplifier, acts as an 87.5 kΩ resistor across one arm of the remote transducer.

Appendix

Iss	Date	Modification
1	8/6/06	New Drawing
2	9/11/06	Note re. unused channels added



For Unused channels

Set Input Gain to **x1**

Set Output Gain to **x 1**

Set Internal 1/2 bridge to '**b**'

Set Shunt balance jumper to '**least sensitive**'

FE-366-TA : User drawing	Ref	Drg No. 1080PC	Issue 2	Date 9/11/06	Checked

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